CHAPTER 3 – TRIP GENERATION

INTRODUCTION

Trip generation is the process of estimating daily person trips for an average weekday generated by households within each Transportation Analysis Zone (TAZ). The Year 2003 Model contains a series of models to estimate trip productions and trip attractions by trip type. The trip production models estimate the number of person trips generated in each TAZ, and trip attraction models estimate the number of person trips attracted to each TAZ.

This chapter provides descriptions of: a) definitions of trip purposes used by SCAG trip generation models, b) the estimation of vehicle availability model, c) trip production and trip attraction methodologies, and d) a summary of model results for the year 2000 as they are compared to the 2001 Travel Survey and for the Year 2003.

TRIP PURPOSE AND TRIP TYPE

The Year 2003 Model uses an expanded set of trip purposes. This was done to improve trip distribution and mode choice estimates, and to more accurately link trip productions and trip attractions. The model contains 9 trip purposes and 14 trip types. Total trips produced by TAZ were estimated for each of the following trip purposes/trip types:

1. Home-based Work

There are six trip types of the home-based work trip purpose: three types of "direct" home-based work trips and three types of "strategic" home-based work trips.

"Direct" home-based work trips are trips that go directly between home and work, without any intermediate stops. The trip generation model estimates these types of trips separately for each of three different personal income (earning by worker) categories:

- "Direct" home-based work trips, Low Income (less than $25,000)
- "Direct" home-based work trips, Medium Income ($25,000 to $49,999)
- "Direct" home-based work trips, High Income ($50,000 or greater)

"Strategic" home-based work trips are trips between home and work that include one or more intermediate stops, such as to drop off or pick up a passenger, to drop off or pick up a child at school, or for other reasons. The trip generation model estimates strategic home-based work trips separately for each of three income categories.

- "Strategic" home-based work trips, Low Income
- "Strategic" home-based work trips, Medium Income
- "Strategic" home-based work trips, High Income

2. Home-based School

Home-based school trips include all student trips with an at-home activity at one end of the trip and a K-12 (kindergarten through 12th grade) school activity at the other end. This purpose does not include trips in the college/university category, which follows.

3. Home-based College and University

Home-based college and university trips include all trips made by persons over the age of 18 with an at-home activity at one end of a trip and a college or university activity at the other end.

4. Home-based Shopping

Home-based shopping trips include all person trips made with a home activity at one end of a trip and a shopping activity at the other end.

5. Home-based Social-recreational

Home-based social-recreational trips include all person trips made with a home activity at one end of a trip and a visiting or recreational activity at the other end.

6. Home-based Serving-passenger

Home-based serving-passenger trips include all person trips made with a home activity at one end of a trip and a passenger serving activity, such as driving someone to somewhere, at the other end. Trips that serve passengers while on the way to work are classified as home based work strategic trips rather than serve passenger trips because they are part of a work trip chain.

7. Home-based Other

Home-based other trips include all other home-based (with a home activity at one end of a trip) trips that are not already accounted for in any of the home-based trips categories described above.

8. Work-based Other

Work-based other trips are non home-based trips where at least one end of a trip is from/to a work location. An example of such a trip would be, “running an errand during lunch hour” from one’s place of employment.

9. Other-based Other

Other-based other trips are all other trips that do not begin or end at a trip-maker's home or place of work.

VEHICLE AVAILABILITY MODEL

The result of vehicle availability model estimation is presented in Table 3-1. This model is estimated using ALOGIT software and the 2001 Travel Survey data. Variables used in the model are listed in Table 3-2. Also, Figure 3-1 compares 2000 model vehicle estimates with 2000 census vehicles.

The auto and non-auto accessibility measures are calculated based on the following equation:

$$A_{ikt} = \ln(1 + \sum_{j} TotalEmployment_j \times \exp^{-2 \times T_{ij}/\hat{T}_{ij}})$$

Where, t is the time period (peak for work and off-peak for non-work); Tij is the peak auto travel time for auto modes and best peak non-auto travel time for non-auto modes; and the Tˆij is the observed mean travel time.

Table 3-1

VEHICLE AVAILABILITY MODEL

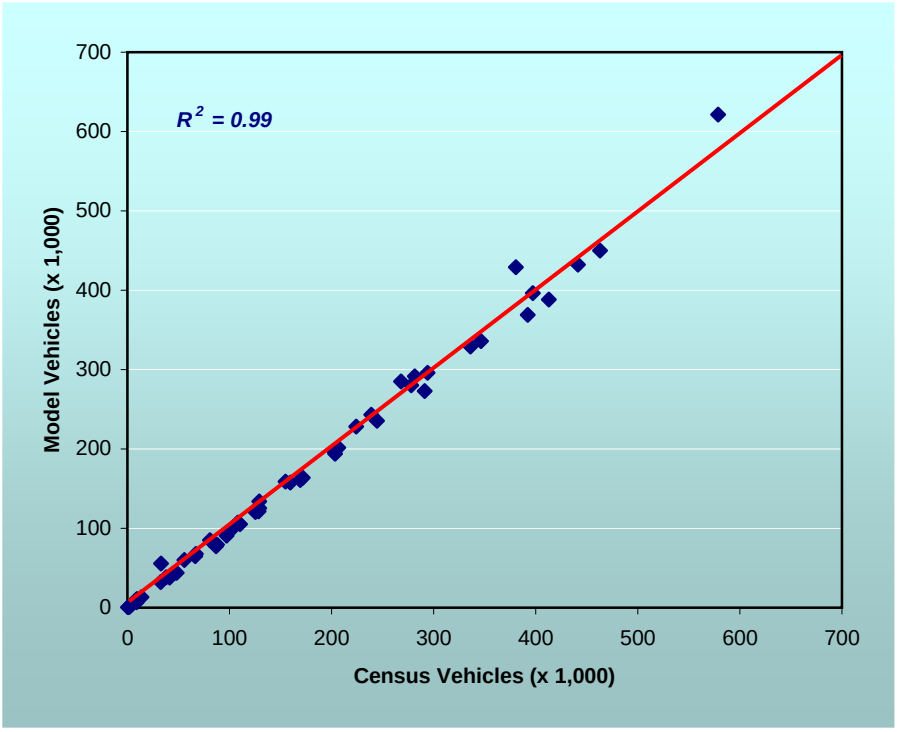
Variable		Vehicle Availability Level			
		1	2	3	4+
Low Income	Coefficient	-2.59	-4.27	-5.2	-5.88
	(t-stat)	*(-15.8)*	*(-25.5)*	*(-27.2)*	*(-23.7)*
Medium Income	Coefficient	-1.12	-2.06	-2.46	-3.04
	(t-stat)	*(-6.3)*	*(-11.5)*	*(-13.2)*	*(-14.6)*
One Worker	Coefficient	0.91	0.91	0.97	0.93
	(t-stat)	*(10.5)*	*(10.5)*	*(7.5)*	*(4.9)*
Two Workers	Coefficient	0.48	1.29	1.43	1.4
	(t-stat)	*(3.3)*	*(9)*	*(8.3)*	*(6.3)*
Three Workers	Coefficient			1.21	1.34
	(t-stat)			*(7.9)*	*(6.2)*
Two-Member Household	Coefficient		1.68	1.12	
	(t-stat)		*(22.6)*	*(9.3)*	
Three-Member Household	Coefficient		1.43	1.31	
	(t-stat)		*(15.2)*	*(9.4)*	
Four or More-Member Household	Coefficient		1.63	1.05	
	(t-stat)		*(17.1)*	*(7.1)*	
Number of Persons Age 16-64	Coefficient		0.49	1.12	1.71
	(t-stat)		*(9.2)*	*(16.8)*	*(26.6)*
Age 65 and over	Coefficient	0.38	0.85	1.51	1.84
	(t-stat)	*(5)*	*(9.3)*	*(14.6)*	*(15.7)*
Non-auto/Auto Acccessibility (work)	Coefficient	-0.6	-0.74	-0.91	-0.94
	(t-stat)	*(-5.6)*	*(-6.5)*	*(-7.3)*	*(-6.5)*
Number of Observations		**14849**			
Final Likelihood		**-15131**			
ρ^2 w.r.t. 0		**0.367**			

Table 3-2

VEHICLE AVAILABILITY MODEL VARIABLE DEFINITIONS

Variable	Definition
Low Income	One if Household Income Less than $25,000, zero otherwise.
Medium Income	One if Household Income between $25,000 and $50,000, zero otherwise.
High Income	One if Household Income greater than $50,000, zero otherwise.
Zero Worker	One if there are zero Workers in the Household, zero otherwise.
One Worker	One if there is one Worker in the Household, zero otherwise.
Two Workers	One if there are two Workers in the Household, zero otherwise.
Two-Member Household	One if there are two members in the Household, zero otherwise.
Three-Member Household	One if there are three members in the Household, zero otherwise
Four or More-Member Household	One if there are four or more members in the Household, zero otherwise.
Age 16-64	One if Age of Head of Household is 16 to 64 years of age, zero otherwise.
Age 65-plus	One if Age of Head of Household more than 65, zero otherwise.

FIGURE 3-1.
2000 MODEL VEHICLE ESTIMATES vs 2000 CENSUS (SCAG RSA)



TRIP PRODUCTIONS

The trip production models applied for the Year 2003 model are "cross-classification" models. By using 2001 SCAG Travel Survey data, trip rates per household are developed for each trip purpose. For example, trip rates for home-based work trip purpose are developed for households stratified by the number of workers, household size, and the age of household head. Trip productions in each zone are then calculated by applying trip rates to the number of households. Appendix C provides a list of trip rates tables (Tables C-1 through C-10). Figure 3-2 shows the comparison of trip production at RSA level between 2000 model result and 2001 travel survey.

The following section describes the independent variables used for cross-classification models for each trip purpose.

Home-Based Work Trip Productions

The household stratification used for the three-way cross-classification models for both home-based work "direct" trips and home-based work "strategic" trips is:

- Household size
- Number of workers in household
- Age group of the head of household

Home-Based Non-Work Trip Productions

Household stratification used for home-based shopping, home-based social recreational, home-based serving passengers, and home-based others trips is as follows:

- Household size
- Number of vehicles available to the household
- Annual household income

For home-based school trips, trip rates are estimated by:

- The number of household members with age between 5 and 17

For home-based college and university trips, a two-way cross-classification model is developed for households by:

- Annual household income
- The number of household members with age between 18 and 24

Non-Home Based Trip Productions

The following is a list of household stratification used for the three-way cross-classification models for non-home based trips.

For work-based other trips:

- Household size
- The number of household workers
- Annual household income

For other-based other trips

- Household size
- The number of household vehicles
- Annual household income

TRIP ATTRACTIONS

Trips attractions are estimated by a set of equations for each trip purpose and trip types defined in this chapter. The methodology of developing trip attraction models is based on multivariate linear regression analysis. The data for independent variable (person trips attracted to a zone) of the regression analysis for each trip purpose come from the expanded survey trips of the 2001 Travel Survey. The data for dependent variables (zonal household and employment data) are developed by SCAG for the year 2000. Figure 3-3 shows the comparison of trip attraction at RSA level between 2000 model result and 2001 travel survey.

Trip Attraction Models

Table 3-3 presents the regression coefficients for the trip attraction models employed in the Year 2003 SCAG Regional Model. Separate regression equations are estimated for each of the following trip purposes:

- Home-Based Work – Direct Trip Attractions
  (Separate equations for low, medium, and high income)
- Home-Based Work – Strategic Trip Attractions
  (Separate equations for low, medium, and high income)
- Home-Based Elementary-High School Trip Attractions
- Home-Based College/University Trip Attractions
- Home-Based Shopping Trip Attractions
- Home-Based Social-Recreation Trip Attractions
- Home-Based Other Trip Attractions
- Work-Based Other Trip "Allocations":
  - Production "Allocations"
  - Attraction "Allocations"
- Other-Based Other Trip Attractions

Figure 3-2

FIGURE 3-2.
2000 MODEL TRIP PRODUCTIONS vs 2001 TRAVEL SURVEY (SCAG RSA)

Purpose	R^2
Total	0.79
HBW	0.74
HBO	0.76
NHB	0.85
HBWD1	0.74
HBWD2	0.72
HBWD3	0.71
HBWS1	0.77
HBWS2	0.76
HBWS3	0.66
HBSC	0.72
HBCU	0.79
HBSH	0.76
HBSR	0.72
HBO	0.76
WBO	0.90
OBO	0.81
HBSP	0.76

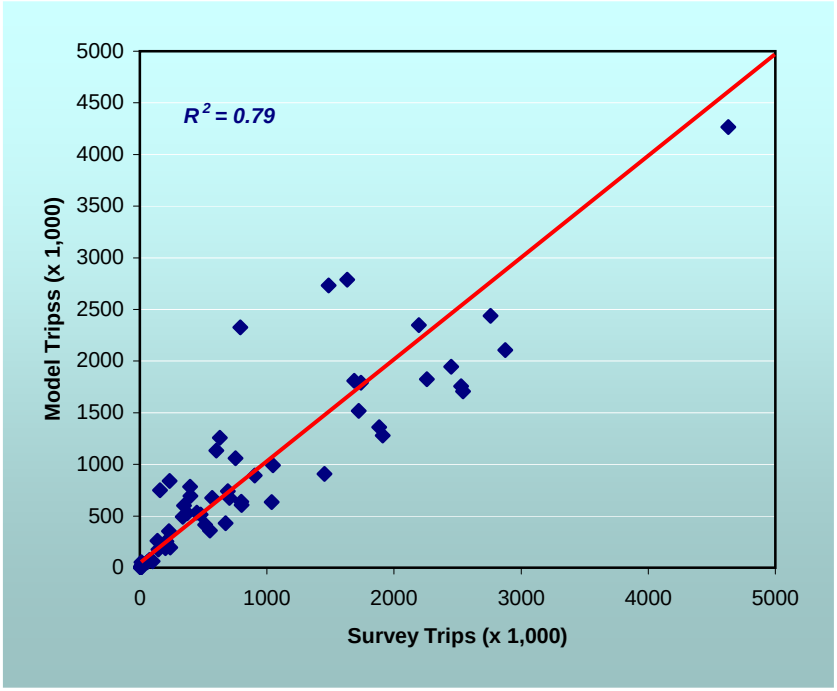


FIGURE 3-3.
2000 MODEL TRIP ATTRACTIONS vs 2001 TRAVEL SURVEY (SCAG RSA)

Purpose	R^2
Total	0.83
HBW	0.88
HBO	0.79
NHB	0.83
HBWD1	0.83
HBWD2	0.86
HBWD3	0.90
HBWS1	0.83
HBWS2	0.85
HBWS3	0.85
HBSC	0.76
HBCU	0.66
HBSH	0.77
HBSR	0.79
HBO	0.79
WBO	0.86
OBO	0.81
HBSP	0.76

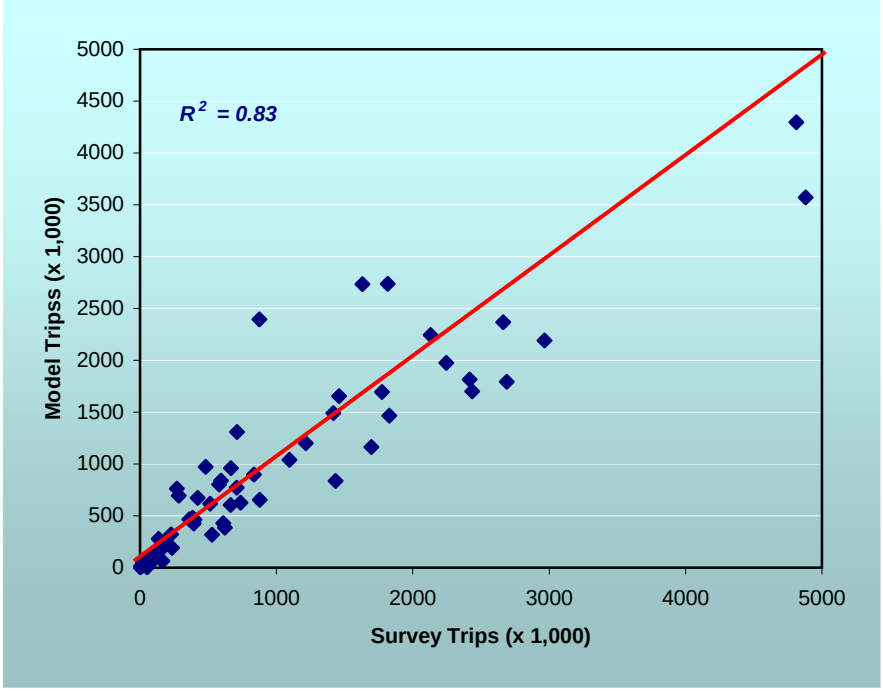


Table 3-3

TRIP ATTACTION MODEL REGRESSION COEFFICIENTS

Trip Purpose	R^2 (CSA)	Households	Total Employment	Residential Population	Low-wage Employment	Medium-wage Employment	High-wage Employment	Retail	Information	Professional Service	Education & Health Service	Arts, Entertainments, Accommodation & Food Services	Other Services	Public Administration	K 12	College Enrollment
HBWD 1 (low income)	0.81				1.181											
HBWD 2 (medium income)	0.90					1.040										
HBWD 3 (high income)	0.90						1.040									
HBWS 1 (low income)	0.76				0.324											
HBWS 2 (medium income)	0.83					0.339										
HBWS 3 (high income)	0.81						0.347									
HBCU	0.77															0.549
HBSC	0.84														1.326	
HBO	0.78			0.270				0.993			0.544	0.993	0.993	3.439		
HBSR	0.75			0.166								2.126				
HBSP	0.72			0.357							0.703					
OBO (Attraction)	0.77	0.508	0.180					4.678			0.698	3.136	3.303			
WBO (Attraction)	0.84	0.036	0.202					0.513				1.147				
OBO (Production)	0.78	0.538	0.162					4.393			1.118	2.568	3.784			
WBO Production	0.85		0.137						0.227	0.250			5.743			

Home-base shop trip attractions are estimated by applying a trip rate R to the zonal retail employment. The Steps for calculating R are as follows:

Step 1: Calculate regionwide resident population to retail employment ratio, r1.
Step 2: Calculate the same ratio for each RSA, r2.
Step 3: Calculate for each RSA the relative retail service index rsi = r2/r1.
Step 4: Range bracket rsi to 0.5 - 1.5
Step 5: Assign this rsi to each TAZ of that RSA.
Step 6: Apply the equation R = 2.105 + 4.108*rsi to estimate the attraction rate.

BALANCING OF TRIP PRODUCTIONS AND ATTRACTIONS

Trip production and trip attraction are balanced to ensure that the same number of trip productions and attractions are generated for each trip purpose. Trip balancing is determined based on the confidence one places in the relative accuracy of trip production model and attraction model for each trip purpose. Except for home-based school and home-based college/university trips which are balanced to trip attractions, all other trip types are balanced to trip productions.

TRIP GENERATION RESUTLS AND FINDINGS

The Year 2003 trip generation model estimated that 58,089,196 person trips were generated for Year 2003 on a typical weekday in the Region's expanded modeling area. About 19.4 percent of total daily person trips are home-based work trips, 51.2 percent are home-based non-work trips, and 29.4 percent are non-home based trips. Table 3-4 identifies the person-trip summary of those trips broken down by county and by trip type.

The previous summary total from the 2000 SCAG model was 55,556,231 person trips for year 2000. It is noted that the 2000 SCAG model covers smaller modeling area and a different set of models.

Table 3-5 provides summary statistics for person trips, by county and for the Region. The Table identifies selected comparative statistics, such as trips per household, trips per vehicle, and trips per capita (person). Table 3-5 also identifies statistics for home-work trips, and total trips. Total trips for Year 2003 are estimated at 10.47 trips per household, 6 trips per vehicle, and 3.3 trips per person.

Table 3-4

YEAR 2003 TRIP GENERATION SUMMARY BY TRIP PURPOSE AND BY COUNTY

TRIP PURPOSE CATEGORY	PERSON TRIP PRODUCTIONS						MODELING AREA TOTAL
	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	
HB Work: Direct - Low Income	37,521	2,409,719	681,462	380,116	402,414	182,385	4,093,616
HB Work: Direct - Middle Income	17,621	1,402,019	483,454	231,982	260,285	125,365	2,520,726
HB Work: Direct - High Income	8,877	1,057,571	468,315	153,826	156,117	117,204	1,961,910
HB Work: Strategic - Low Income	12,661	748,271	210,662	122,039	129,283	58,013	1,280,928
HB Work: Strategic - Middle Income	5,896	431,242	148,158	74,690	83,647	39,715	783,348
HB Work: Strategic - High Income	2,962	324,450	144,191	49,584	50,402	37,231	608,820
Total Home Based Work	***85,537***	***6,373,271***	***2,136,243***	***1,012,238***	***1,082,147***	***559,912***	***11,249,349***
HB School	49,542	2,789,294	772,569	508,005	584,044	220,395	4,923,849
HB College/University Trips	5,108	405,508	121,837	51,252	66,856	26,989	677,550
HB Shopping	39,233	2,793,958	857,083	504,447	514,901	229,876	4,939,498
HB Social-Recreational Person Trips	33,346	2,410,188	759,303	456,324	460,866	212,288	4,332,314
HB Other Purpose Person Trips	61,248	4,277,544	1,289,093	762,077	787,546	348,147	7,525,656
HB Serving Passengers	65,953	4,177,635	1,212,762	739,965	811,372	327,306	7,334,993
Total Home Based Non-Work	***254,430***	***16,854,127***	***5,012,646***	***3,022,069***	***3,225,586***	***1,365,002***	***29,733,860***
Work - Other Person Trips (NHB)	17,964	2,140,772	732,739	272,443	291,475	153,029	3,608,422
Other - Other Person Trips (NHB)	93,034	7,694,186	2,641,540	1,224,937	1,246,822	597,048	13,497,566
Total Non-Home Based	***110,998***	***9,834,957***	***3,374,279***	***1,497,380***	***1,538,297***	***750,077***	***17,105,987***
TOTAL PERSON TRIPS	**450,966**	**33,062,356**	**10,523,168**	**5,531,687**	**5,846,030**	**2,674,991**	**58,089,196**

Notes: HB = Home-based, NHB = Non-home Based

Table 3-5

YEAR 2003 TRIP GENERATION COMPARATIVE STATISTICS

Home-Based Work Trips	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	Total
TRIPS	85,537	6,373,271	2,136,243	1,012,238	1,082,147	559,912	11,249,349
TRIPS per HOUSEHOLD	2.06	2.01	2.22	1.81	1.95	2.20	2.03
TRIPS per VEHICLE	1.18	1.22	1.18	1.00	1.04	1.12	1.16
TRIPS per WORKER	1.57	1.58	1.54	1.50	1.51	1.56	1.56
% Home-Based Work Trips	19.0%	19.3%	20.3%	18.3%	18.5%	20.9%	19.4%

Home-Based Non-Work Trips	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	Total
TRIPS	254,430	16,854,127	5,012,646	3,022,069	3,225,586	1,365,002	29,733,860
TRIPS per HOUSEHOLD	6.12	5.31	5.20	5.39	5.83	5.36	5.36
TRIPS per VEHICLE	3.52	3.22	2.77	2.98	3.11	2.73	3.07
TRIPS per Person	1.65	1.68	1.67	1.73	1.72	1.71	1.69
% Home-Based Non-Work Trips	56.4%	51.0%	47.6%	54.6%	55.2%	51.0%	51.2%

Non-Home-Based Trips	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	Total
TRIPS	110,998	9,834,957	3,374,279	1,497,380	1,538,297	750,077	17,105,987
TRIPS per HOUSEHOLD	2.67	3.10	3.50	2.67	2.78	2.95	3.08
TRIPS per VEHICLE	1.54	1.88	1.86	1.48	1.49	1.50	1.77
TRIPS per Person	0.72	0.98	1.13	0.86	0.82	0.94	0.97
% Non-Home-Based Trips	24.6%	29.7%	32.1%	27.1%	26.3%	28.0%	29.4%

Total Trips	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	Total
TRIPS	450,966	33,062,356	10,523,168	5,531,687	5,846,030	2,674,991	58,089,196
TRIPS per HOUSEHOLD	10.84	10.41	10.92	9.87	10.56	10.51	10.47
TRIPS per VEHICLE	6.24	6.31	5.81	5.46	5.64	5.34	6.00
TRIPS per PERSON	2.92	3.30	3.51	3.16	3.12	3.35	3.30